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Safe Motherhood—Results from Rwanda

- Competency of Skilled Birth Attendants
- The Enabling Environment for Skilled Attendance at Delivery
- In-Hospital Delays in Obstetric Care (Documenting the Third Delay)

Maina Boucar, Maurice Bucagu, Sabou Djibrina, Wendy Edson, Barton Burkhalter, Steven A. Harvey, and Cathy Antonakos

May 2004

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OPERATIONS RESEARCH RESULTS

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Abstract

Each year, more than 500,000 women worldwide die from complications related to childbirth. With good quality obstetric care, approximately 90% of these deaths could be averted. The assistance of a skilled birth attendant during labor, delivery, and the immediate postpartum period is one important component of quality obstetric care. An enabling environment for skilled attendance at delivery and prompt attention for women arriving at a medical facility with an obstetric complication are also key factors. However, little is known about the competence of skilled birth attendants (SBAs), the elements that contribute to an enabling environment, and the causes of what is commonly known as the “third delay”: the delay in receiving medical attention after a woman arrives at a healthcare facility.

Through its Safe Motherhood Research Program, the Quality Assurance Project carried out three studies to explore these issues in countries with high maternal mortality ratios. The first study examined the competency of SBAs. The second measured SBA performance and the relative contribution to performance of different enabling factors in the work environment. The last examined causes of in-hospital delays in receiving obstetric care. All three studies occurred between September 2001 and July 2002 in Benin, Rwanda, Ecuador, and Jamaica. This report presents the results from Rwanda, where three hospitals participated: a tertiary care referral hospital with an active maternity department and two regional hospitals.

The competency study measured knowledge with a 58-question test covering six subject areas. We also tested skills in several key areas, including ability to use a partograph, neonatal resuscitation, manual removal of placenta, bimanual uterine compression, and insertion of an intravenous needle. Finally, we asked participants to assess their own ability to carry out common obstetric procedures. Results show low competency levels with a mean score of 47% correct. Active management of third stage labor merits specific mention, as the mean score was only 7%. The overall test scores for doctors, professional nurses, and midwives were quite similar, while scores for technical nurses were significantly lower. There were too few doctors and midwives to compare skills scores in a statistically reliable way; however, professional nurses scored significantly higher than technical nurses overall, for mouth-to-mouth and nose resuscitation, and asepsia. There was no correlation between providers’ self-assessment and their competency as measured by the knowledge and skills tests.

The enabling environment study addressed the contribution of enabling factors and essential elements to health worker performance. We used an observation checklist to evaluate performance during labor, delivery, and the immediate postpartum period. We reviewed medical records to evaluate performance in managing obstetric complications. We also surveyed providers in each facility about supervision, training, and motivation. Finally, we inventoried the availability of essential drugs, equipment, and supplies in each study hospital. Labor monitoring, including checking fetal heart rate and the mother’s blood pressure, was inadequate in most observed cases. Providers used a partograph only about a third of the time. Few washed their hands before assisting at delivery, and only about half cleaned the perineum before birth; most administered oxytocin to the mother after delivery.

The third delay study used direct observation to analyze patient flow in all three study hospitals. In addition, three physicians reviewed medical records to reveal any delays at different points in patient care: Most of the delays they found occurred during diagnosis, especially for obstructed labor. Waiting times after arrival at the hospital or the OB department were short, averaging 13 minutes, with one regional hospital averaging only 3 minutes. The mean time from decision to operate and start of a cesarean section at the tertiary hospital was about two hours. Antibiotics were administered only 44 minutes on average after an order at the tertiary hospital.

Acknowledgements

The Quality Assurance Project would like to acknowledge our organizational partners who enabled these studies to be carried out in Rwanda: Thomas Karangera and Claude Sekabarage of the Rwanda Ministry of Health; the director of Kigali Central Hospital (CHK); Apolline Uwayitu, Elizabeth Drabant, and Barbara Sow of the U.S. Agency for International Development (USAID) Mission in Rwanda; and Dr. Maurice Bucagu, this study's director, of the National University of Rwanda.

In the U.S. and the other study countries, many colleagues made important contributions to the design of the studies, including David Nicholas of the Quality Assurance Project; Stephane Legros of the World Bank; Jorge Hermida and Patricio Ayubaca of the Quality Assurance Project in Ecuador; Affette McCaw-Binns of the University of West Indies; and Sourou Gbangabade, country coordinator for the maternal health studies in Benin. We would also like to thank the group of expert technical advisors who provided excellent support in the planning phase and throughout the project, including Colleen Conroy, Marge Koblinsky, Jeanne McDermott, Allisyn Moran, Elizabeth Ransom, Cindy Stanton, Mary Ellen Stanton, and Patricia Stephenson, and the U.S.-based support team, including Elisa Knebel for literature review, Rais Mazitov and Marta Woodward for data input, and Ebie Dupont for administrative support.

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I. Introduction

A. Background

The Quality Assurance Project (QAP) carried out three studies in countries with high maternal mortality ratios: the first examined the competency of birth attendants, the second measured performance and gauged the relative contribution of different enabling factors within the work environment, and the last examined delays in treating obstetric emergencies. The three studies were implemented between September 2001 and July 2002 in Benin, Ecuador, Jamaica, and Rwanda. This report presents the results from Rwanda, where data were collected during March of 2002.

According to WHO estimates, the maternal mortality ratio (MMR) for Rwanda was 2318 deaths for every 100,000 live births in 1995.[1] This rate is more than double the MMR of 1006 per 100,000 for the Africa region as a whole. Worldwide, over 500,000 women die each year from complications related to childbirth.[1,2] Only an estimated 30.8% of deliveries in Rwanda are attended by trained health personnel, and only about 26.5% occur in health facilities.[3] Midwives and nurses attend most hospital deliveries there, and physicians serve as the back-up for obstetric (OB) emergencies and forceps and cesarean section (C-section) deliveries.

Abbreviations

ANOVA	Analysis of variance
BEOC	Basic Essential Obstetric Care
CEOC	Comprehensive Essential Obstetric Care
CHK	Kigali Central Hospital
CI	Confidence interval
C-section	Cesarean section
DHS	Demographic and Health Survey
EOC	Emergency obstetric care
ER	Emergency room
FHR	Fetal heart rate
HW	Health worker
IMPAC	Integrated Management of Pregnancy and Childbirth
IV	Intravenous
$MgSO_4$	Magnesium sulfate
MMR	Maternal mortality ratio
NA	Not Applicable
OB	Obstetric
Ob/Gyn	Obstetrician/gynecologist
PIH	Pregnancy-induced hypertension
QAP	Quality Assurance Project
SBA	Skilled birth attendant
SD	Standard deviation
UNICEF	United Nations Children's Fund
UNFPA	United Nations Fund for Population Activities

Maternal experts agree that skilled attendance "during labor, delivery, and in the early postpartum period" is perhaps the most important key to reducing maternal mortality.[4-7] In fact, percentage of births assisted by a skilled attendant has become a proxy indicator for progress in reducing maternal mortality.[8] However, consensus is lacking on how to define "skilled attendant." Absent such a definition, many rely on Demographic and Health Survey (DHS) data reporting the percentage of deliveries assisted by "health personnel": typically doctors, nurses, and nurse midwives. Though the DHS program does not assess the knowledge or skills of the attendants it categorizes as "health personnel," others who extrapolate from DHS data use the terms "health personnel" and "skilled birth attendant" (SBA) interchangeably.[9]

Unfortunately, we have limited information about the competence of SBAs in managing labor, delivery, and the immediate postpartum period. We also know little about their competence at managing the five most common life-threatening complications of childbirth: hemorrhage, pregnancy-induced hypertension (PIH), sepsis, obstructed labor, and post-abortion complications.[10]

Competent attendance can make an important contribution towards improving birth outcomes and reducing maternal morbidity and mortality, but even a highly competent attendant needs an enabling environment to perform optimally. The elements of an enabling environment include the availability of essential drugs and equipment, leadership, supervision, job aids, policies, guidelines, and even the process used to develop and adopt standards. Also critical is the way services are organized to facilitate or impede the delivery of care. We know little about the presence or absence of specific environmental factors in high maternal mortality settings. Similarly, we know little about the relative contribution of these different factors to performance outcomes.

A key contributor to maternal death when an obstetric complication occurs is the delay in receiving care once a woman arrives at a health facility. This is the third in what has become widely known as the three-delay model of maternal mortality.[11] Many factors contribute to this delay: lack of personnel, supplies, and equipment; delay in reaching a diagnosis; inability of the patient or her family to pay for care, drugs, or supplies; and the time of day or day of the week when the patient arrives, among others.[12-18] While studies have examined different aspects of the third delay in different settings, there is a need to define this delay more clearly for the five major causes of maternal mortality mentioned above. There is also a need to specify acceptable time intervals between a woman's arrival at a facility with a particular obstetric complication and the start of treatment for that complication. Finally, different studies have attempted to measure time intervals between arrival and treatment by several different methods, but it is not clear which of these are most reliable and practical in high maternal mortality settings.

B. Research Design

1. Study instruments

We pilot tested all study instruments in Ecuador during November and December 2001. After revision, instruments were translated into English and then into French in late February of 2002. All instruments were then reviewed by study personnel in Rwanda for applicability to the Rwanda healthcare setting. All francophone personnel received the French versions of the instruments for the competency tests and all Anglophone personnel the English versions. As there were no finalized Rwanda guidelines for obstetrical care at the time of the study, all measures were based on the Integrated Management of Pregnancy and Childbirth (IMPAC) international guidelines developed by WHO, UNFPA, UNICEF, and the World Bank.[19] Data collection instruments are listed in Appendix A.

The data collectors were trained during a one-day session. All data collectors—two obstetricians, a pediatrician, and five midwives—were practicing obstetrics at sites other than the study sites. The training included the rationale for the study, how the study fit into the QAP country program, the Rwanda Ministry of Health objectives, and how the results would be used to improve the quality of care. Training also presented a review of each data collection instrument and clarified the intent of each item in the instruments. With regard to the observation of the delivery of care, the data collectors were told that if during an observation they became concerned with the care or well being of a patient, they should cease observing and intervene as they would normally do in their practice.

All approvals were obtained to conduct the three studies. Participation in all studies was voluntary.

2. Study sites and sample characteristics

Study hospitals were selected purposively according to the following criteria:

1. A range of levels of care, including one large urban referral (tertiary care) hospital with an active maternity department that manages a large number of maternal complications; two mid-sized (secondary care, regional) hospitals; and four health centers, which referred to the regional hospitals.
2. An average of at least two births per day, sufficient to permit observation of at least five over a two- to three-day period;
3. At least some facilities outside the capital city but geographically close enough to be manageable within the time and budget available;
4. Facilities where QAP in Rwanda was conducting program activities.

Based on the criteria proposed by Maine, two hospitals selected for the study qualified as Comprehensive Essential Obstetric Care (CEOC) facilities.[20] The third would normally have qualified but was not because the anesthesiologist had recently transferred and had not been replaced. However, this hospital did qualify as a Basic Essential Obstetric Care (BEOC) facility. The four health centers were not evaluated to determine whether they met the BEOC or CEOC criteria.

3. Data collection procedures

Two teams of two data collectors each were formed during the training session with an obstetrician serving as team leader. Each team had a vehicle, driver, and pre-paid hotel and per diem expenses. At the end of the training, each team was asked to organize its work schedule to ensure that all deliveries during a three-day period at the two regional hospitals would be covered. The following day, the teams left for these hospitals, where the QAP in-country team met them and facilitated their introduction to the hospital director and maternity department. After three days of observations, the competency testing of all maternity staff at Ruhengeri Hospital was done in one day. The competency testing at Rwamagana Hospital was done over two days: the first day for the written tests and the second day for the skills tests. Before starting the observations at the Kigali Central Hospital (CHK), the data collectors met again with the QAP study team to debrief, review completed instruments, and plan for observations and competency testing at the large hospital. The observations and competency testing at CHK were conducted next. Lastly, a sample of obstetric emergencies was selected at each of the three hospitals, and those medical records were reviewed. A schedule of the in-country data collection activities is in Appendix B.

Before data collection, all study sites were visited twice by the in-country team: Dr. Bucagu, Dr. Boucar, Mr. Djibrina, and Dr. Edson. During these site visits, we briefed the facility director on the three studies and received permission to conduct the studies in that facility. We mapped the physical layout of the facility in order to determine the placement of observers for a patient flow analysis. We also contacted the medical records department to coordinate the selection of the medical records for review and the maternity department to coordinate the start of observation of deliveries and identification of personnel. Finally, we established a location, date, and time for the competency testing of hospital personnel.

Table 1 presents the number of study instruments completed in Rwanda by facility.

Table 1. Study instruments completed by facility

Hospital Type Location	Competency Study: Knowledge Surveys	Competency Study: OB Skills Stations	Competency Study: Provider Self-Evaluations	Enabling Environment Study: Births Observed	Enabling Environment Study: Essential Elements Checklist	Enabling Environment Study: Enabling Factors Survey	Third Delay Study: Medical Records Audited	Third Delay Study: Obstetric Ward Observations
Reference (Level III) Kigali	18	5	16	40	1	18	30	44
Regional (Level II) Ruhengeri	9	7	9	13	1	9	25	13
Regional (Level II) Ruhengeri	3	3	3	7	1	3	30	7
Health centers (Level I)	4	4	4	-	4	4	-	-
Total	**34**	**19**	**32**	**60**	**7**	**34**	**85**	**64**

II. Competency Study

A. Objectives

The objectives of the Competency Study were to develop, test, and apply instruments to measure the competency of health personnel who attend women during labor, delivery, and in the immediate postpartum period. More specifically, we intended to develop assessment methods that would be both valid measures of key competencies and "practical for program managers." By practical for program managers, we mean: (1) simple to apply and evaluate locally without assembling a large study team or hiring outside consultants; (2) rapid (testing applicable in a day or less) so as not to remove essential health personnel from their duties for a long period of time; and (3) based on technology that is affordable and applicable in limited-resource settings, such as Ministry of Health facilities with no budget or personnel dedicated specifically to research and evaluation.

B. Methods

Following quality improvement literature, we defined competence as the possession of knowledge and skills sufficient to comply with predefined clinical standards.[21] Since cross-country comparisons were a key goal of the study, we used WHO IMPAC guidelines as a benchmark for our measurements.[19] To measure knowledge, we developed a 55-question, multiple-choice and fill-in-the blank test with six topic areas: aseptic procedure; labor and delivery; immediate newborn care; and management of hemorrhage, PIH (pre-eclampsia and eclampsia), and sepsis. Questions were adapted from training evaluation instruments developed by MotherCare and the Maternal and Neonatal Health Project.[22-24] Additional sources of information included the list of basic SBA competencies developed by the Safe Motherhood Interagency Group and consultation with experts both internationally and in Rwanda. Three questions were added to the knowledge test in Rwanda on the management of a pregnant woman with malaria, making a total of 58 questions.

In scoring the test, we awarded one point for each correct answer but did not deduct points for incorrect or blank answers. To calculate a total score, we divided the total points earned by the total points possible on the version of the test used by that provider. The denominator, total points possible, varied slightly in different facilities because two questions were dropped in some facilities and three questions were added in others. Each score is expressed as the percentage of total questions answered correctly. We also examined partial scores on questions related to our six topic areas. To calculate partial scores, we assigned one point for each correct answer related to each topic and divided the result by the number of questions related to that topic.

To measure skills, we adapted five instruments developed by the Maternal and Neonatal Health Program: (1) ability to use a partograph as a decision-making tool in labor and delivery; (2) neonatal resuscitation with an ambu bag; (3) neonatal resuscitation, both mouth-to-mouth and nose; (4) manual removal of placenta; and (5) bimanual uterine compression.[24] A similar approach was used by MotherCare in Indonesia.[22] We also developed a checklist for measuring skill at intravenous (IV) needle insertion, a critical aspect of managing pre-eclampsia, eclampsia, and many other complications of pregnancy and childbirth.

The knowledge test and the partograph exercise were administered in written form. During the partograph exercise, participants were presented with data from two different cases: one each of prolonged labor and acute fetal distress. Participants were asked to plot the data on a partograph and to answer questions about how they would manage each case using the data and the plots. Participants also rotated through five skills stations modeled on Objective Structured Clinical Evaluations similar to those described by McDermott.[22] At each station, each participant was asked to perform a procedure on an anatomical model. Evaluators instructed each participant to prepare for the procedure, carry it out, and then complete post-procedure tasks exactly as if treating a real patient. Evaluators included one pediatrician (for the neonatal stations), one Ob/Gyn (for the obstetric skills stations), and a midwife (for the IV insertion station). Evaluators scored participant competency at each station using a structured observation checklist.

Finally, we asked participants to evaluate their own abilities in seven key areas: (1) infection prevention and equipment sterilization, (2) use of a partograph, (3) active management of third-stage labor, (4) manual removal of placenta, (5) bimanual uterine compression, (6) neonatal resuscitation, and (7) IV insertion. Participants ranked the difficulty of each task on a four-point scale: "very easy," "easy," "a little bit difficult," and "very difficult." Other options included "I never do this skill/procedure" and "don't know/not applicable." Participants completed this self-evaluation survey at the same time as the knowledge test and the partograph exercise. To permit comparison between competency and performance (measured as part of the Enabling Environment Study), providers at each study facility were first observed attending one or more actual deliveries.

C. Results

Thirty-four providers from the four hospitals and three health centers completed the knowledge test. Those tested included four attending physicians (*medecin asistant*), six certified nurse midwives (*sage-femme*), 17 professional nurses (*infermier A2*), one general practitioner (*medecin generaliste*), five technical nurses (*infermier A3*), and one medical intern. Time required for completion of the knowledge test and the other written instruments was much longer than the anticipated four hours: in some cases up to six hours. Participants complained that the knowledge test was too long. Reading the French may have been difficult for some hospital personnel, as they were accustomed to speaking in Kinyarwanda, but providers also had great difficulty comprehending the questions and selecting the correct responses. The skills tests were easier to administer as they were done verbally.

The mean overall score for the knowledge test was 46.6% correct (95% CI 42.0-51.2, SD 13.2%). Table 2 presents mean scores for the test as a whole and for each of the six topic areas. All scores are reported as a percentage of questions answered correctly. Given the small number of providers in each category and at each hospital, it was not possible to test for differences in score by type of provider or by individual facility. However, grouping all doctors into a single category (n=6, including *medecin asistant, medecin generaliste,* and *interne*) made clear that the overall test scores for doctors, professional nurses, and midwives were quite similar, while scores for technical nurses were significantly lower. Technical nurses' scores were also lower for specific topic areas of the test.

Table 2. Knowledge test scores (n=34)

Topic Area	Number of Questions	Mean	95% CI	SD
Total score[1]	55-58	46.6	42.0-51.2	13.2
Asepsia/antisepsia	7	34.5	26.0-42.9	24.1
Labor and delivery	24	51.5	46.3-56.7	14.9
Immediate newborn care	11	44.1	37.0-51.2	20.4
Postpartum hemorrhage	13	43.4	38.3-48.6	14.7
Pregnancy-induced hypertension[2]	9	52.0	43.8-60.2	23.5
Sepsis	6	39.2	31.7-46.8	21.6
Active management of third stage labor	2	7.4	1.1-13.6	18

[1] The total number of questions varied by test version; three different versions were used in different facilities.

[2] The test included 11 questions on PIH. Two were dropped from analysis because no participants answered them correctly, and these answers were not correlated with responses to other PIH-related questions.

Re-categorizing health facilities by level of care (reference hospital [n=18]), district hospital [n=12], and health center [n=4]) revealed significantly lower scores for health center providers compared to district and reference hospital providers. These results must be interpreted with caution since the sample of providers from health centers is extremely small: n=4, with one provider from each center included in the study. Differences in scores between different provider types or providers from different types of facilities were determined using analysis of variance (ANOVA) with the Bonferroni post-hoc test.[25]

Twenty-seven providers completed the two partograph case studies. Of these, 18 came from the reference hospital, five from the two district hospitals, and one from each of the four health centers. The group included four attending physicians, six midwives, 14 professional nurses, and three technical nurses. The mean overall score for the two cases combined was 49.8% correct (95% CI 42.8-56.9%, SD 17.8%). On average, participants scored significantly higher on the first case (mean score 57.5%, 95% CI 49.7-65.2%) than on the second (33.8%, 95% CI 23.6-44.1%). Participants did slightly better at answering written questions (mean score 50.1%) than at plotting information on the partograph (48.5%). ANOVA found no significant differences in mean score on the partograph test by type of provider or by type of health facility. Any such differences might have been obscured by the small number of providers in the different subcategories.

Only 19 providers completed the skills-based portion of the competency evaluation, 15 altogether from the three hospitals plus one from each of the four health centers. As the full day of testing was too long, some providers stayed for only the written portion and left before they could be tested on the anatomical models. The 19 included one attending physician, three midwives, 10 professional nurses, and give technical nurses. As noted above, each skill station was organized into three parts: preparing for the procedure, carrying out the procedure, and completing post-procedure tasks. In the preparatory and post-procedure parts of each station, participants were evaluated on their compliance with standards for aseptic procedure (e.g., washing hands, using new or re-sterilized gloves, disinfecting equipment, and disposing of or disinfecting gloves properly). These parts also included something we call “patient rapport”: Did the provider greet the patient, explain what he or she was going to do, provide emotional support, and explain the outcome afterwards, etc.? Before examining scores for each skill individually, we tested for significant differences in mean score between the preparatory and post-procedure tasks versus tasks associated with the procedure itself. Since the evaluations were carried out with anatomical models rather than real patients, we hypothesized that providers might pay more attention to the procedure itself than to asepsia and patient rapport. If this were the case, we expected higher scores on the middle part of each skill station than on the first or third part.

T-tests showed significantly higher scores on the procedure part of the test for manual removal of placenta ($p<0.01$) and IV insertion ($p<0.001$). In light of this finding, we based the analysis on the total score (pre- + procedure + post-) for the two neonatal resuscitation stations and for bimanual uterine compression, but on the procedure score alone for manual removal of placenta and IV insertion. We also created an overall competency score for asepsia and for patient rapport by summing the questions from each station related to these topics. Table 3 displays mean scores overall, scores for each station, and scores for asepsia and patient rapport. All scores are reported as a percentage of questions answered correctly.

Table 3. Skills station scores (n=19)

Skill Station/Index	Mean	95% CI	SD
Overall skill	50.2	42.3-58.0	16.3
Resuscitation with ambu bag	43.3	35.4-51.1	16.4
Resuscitation: mouth-to-mouth and nose	44.7	38.4-51.1	13.2
Manual removal of placenta*	58.3	44.8-71.9	28.1
Bimanual uterine compression	40.2	27.3-53.1	26.7
IV insertion*	87.1	81.4-92.8	11.9
Asepsia	53.7	45.6-61.7	16.7
Patient rapport	32.7	22.3-43.1	21.6

* Procedure scores rather than total scores are reported for these stations.

Given the small number of providers who completed the skills tests, it is difficult to draw conclusions about differences in scores between subgroups. However, the general pattern was similar to that seen with the knowledge test. For most of the individual skills stations, health center providers scored quite a bit lower than providers from the reference hospital but only slightly lower than providers from the regional hospitals. A larger sample size might have made it possible to distinguish significant differences in scores between reference hospital and regional hospital providers. There were too few doctors and midwives to test scores by the four subgroups compared for the knowledge test. However, t-tests showed that professional nurses (n=10) scored significantly higher than technical nurses (n=5) overall ($p=0.05$), for mouth-to-mouth and nose resuscitation ($p=0.02$), and for asepsia ($p<0.001$). Differences in scores between these two groups were marginally significant for resuscitation with an ambu bag ($p=0.07$) and manual removal of placenta ($p=0.08$). Figure 1 illustrates the difference between overall knowledge and skills scores for technical nurses compared to all other providers.

Figure 1. Knowledge and skills by provider type

Thirty-two participants completed the self-evaluation survey. Of those answering each question, most reported that all seven procedures or tasks were either "easy" or "very easy," though a significant number reported that they rarely or never performed some tasks. The only exception was neonatal resuscitation, which 51.5% of respondents reported was difficult or very difficult compared to 42.4% who said it was easy. We tested for correlation between self-assessment and score (1) on the related part of the knowledge test and (2) in the related skills station. There were no significant correlations between self-assessment and score on any of the seven skills. Table 4 compares the self-assessment results to each related portion of the knowledge and skill evaluations.

Table 4. Comparison of provider self-assessment and test score (in percentages)

<table>
<tr><th rowspan="2">Task</th><th colspan="4">Provider Self-Assessment</th><th rowspan="2">Actual Test Score[1]</th></tr>
<tr><th>n</th><th>Easy or Very Easy</th><th>Difficult or Very Difficult</th><th>I Don't Perform This Task</th></tr>
<tr><td>Use a partograph</td><td>33</td><td>54.5</td><td>42.4</td><td>3.0</td><td>49.8</td></tr>
<tr><td>Equipment sterilization/infection prevention[2]</td><td rowspan="2">29</td><td rowspan="2">48.3</td><td rowspan="2">27.6</td><td rowspan="2">24.1</td><td>34.5</td></tr>
<tr><td>Equipment sterilization/infection prevention[3]</td><td>53.7</td></tr>
<tr><td>Active management of third stage labor</td><td>29</td><td>82.8</td><td>17.2</td><td>-</td><td>7.4</td></tr>
<tr><td>Manual removal of placenta</td><td>30</td><td>53.3</td><td>36.7</td><td>3.3</td><td>58.3</td></tr>
<tr><td>Bimanual uterine compression</td><td>23</td><td>69.6</td><td>21.7</td><td>8.7</td><td>40.2</td></tr>
<tr><td>Neonatal resuscitation (ambu bag)</td><td rowspan="2">33</td><td rowspan="2">42.4</td><td rowspan="2">51.5</td><td rowspan="2">6.1</td><td>43.4</td></tr>
<tr><td>Neonatal resuscitation (mouth-to-mouth/nose)</td><td>44.7</td></tr>
<tr><td>IV Insertion</td><td>33</td><td>87.9</td><td>6.1</td><td>6.0</td><td>87.1</td></tr>
</table>

1. Percentage correct on knowledge test questions or skills station.
2. As measured by the knowledge test.
3. As measured by the skills stations.

D. Discussion

1. Data collection

The knowledge test was quite long, particularly given that participants were asked to complete the partograph case studies and respond to questions on their work environment at the same time. All told, these written exercises took some participants more than four hours. Based on our experience at the three study hospitals, we recommend shortening the knowledge test to a more manageable length. Given the apparent difficulty some providers—particularly the technical nurses—had answering written test questions, we also recommend exploring an oral exam in each participant's primary language.

The amount of time necessary to complete the skills stations depends on both the number of participants and the number of anatomical models and observers available. Each station requires a minimum of 20 minutes per participant. The two obstetric stations require about 30 minutes per participant, since the tasks are more numerous and more complex. Unless the timing of the exercise is carefully scheduled and the flow of participants through the skills stations carefully managed, participants can face long waits from the time they finish one skill station until the time another becomes available. This caused hardships for some participants and contributed to the fall-off in participation between the knowledge test and the skills stations.

One way to avoid these difficulties would be to increase the number of anatomical models and observers: With two pelvic models and two neonate models, it is possible to test five participants simultaneously. A second IV arm would also be useful, since this station requires less time than the other four. However, buying additional models and hiring additional observers would significantly increase the evaluation cost.

Another option would be to test fewer providers on any given day. This would reduce bottlenecks between skills stations and eliminate the need for more models and observers. However, it would require paying observers for a longer period. More importantly, it would open the possibility that providers who had completed the evaluation would share information with and provide coaching to their colleagues. This issue was noted by McDermott et al. during their work in Indonesia and was one of the reasons we elected to test all providers from a given facility at the same time.[22] The most viable solution might be to reduce the number of questions on the knowledge test and schedule the knowledge test and the skills stations over two simultaneous sessions. With this approach, half the participants would complete the written exercises in the morning while the other half worked their way through the skills stations. Then the groups would switch places in the afternoon.

2. Findings

According to national standards, technical nurses (*infermier A3*) are not supposed to deliver babies in Rwanda: They are meant to serve as health center support staff to help with cleaning equipment and similar tasks. However, the 1994 genocide in Rwanda led to the deaths of so many doctors, midwives, and professional nurses (*infermier A2*) that there are insufficient numbers of more highly trained professionals to attend births, especially in rural areas. As a result, technical nurses now attend an estimated 60–80 percent of health center deliveries. Further, a program that once provided technical nurses with three years of pre-service training beyond primary school has been eliminated.[26]

Despite the small sample size, the large differences in score between technical nurses and other types of providers (see Appendix C) convince us that these observed differences in scores represent real differences in clinical competency. The fact that technical nurses receive such limited training reinforces this conclusion. As a result, we recommend giving a high priority in the short term to developing initiatives to upgrade the basic obstetric skills of technical nurses.

Though the scores of doctors, midwives, professional nurses, and medical interns were considerably better than those of technical nurses, they are not in themselves particularly reassuring. A competence score of around 50% for overall knowledge and around 55% overall for skills leaves considerable room for improvement. Scores on knowledge related to normal labor and delivery and management of pregnancy-induced hypertension were slightly higher than on other sections of the test. Similarly, skill in manual removal of placenta was slightly higher than for other procedures related to obstetric and neonatal complications. Still, it seems clear that work is needed in all these areas.

Active management of third stage labor merits specific mention: The international Safe Motherhood movement considers it to be a key intervention for reducing morbidity and mortality associated with postpartum hemorrhage.[27] Our knowledge test had two questions on this topic. Only five out of 34 participants (14.7%) answered at least one of these questions correctly, and no one answered both correctly. In other words, 29 of the 34 participants (85.3%) answered both questions incorrectly. Active third stage management is a relatively simple and low-cost intervention; implementing it in Rwanda might save significant numbers of lives without requiring unsustainable levels of resources.

Self-assessment has been shown to be not very accurate during performance appraisals as individuals either over- or under-rate their performance. When used as a tool to assess learning needs prior to a training program, self-assessment has, however, been accurate.[28] Respondents were asked by outside researchers led by senior medical personnel to complete the competency exams. They had no expectation of further training or supervisory action as the results were to be kept confidential. In this context self-assessment was not an accurate reflection of competence.

III. Enabling Environment Study

A. Objectives

The objective of the Enabling Environment Study was to better understand the relative contribution of core enabling factors and essential elements to the performance of health personnel who attend women during labor, delivery, and in the immediate postpartum period. To the extent possible, we also hoped to assess the relative contribution of competency to performance in the context of environments with different enabling factors and essential elements.

B. Methods

Examining how different environmental factors influence performance requires measuring performance itself (as an outcome variable) and the factors thought to contribute to it (as explanatory variables). As one performance measure, we used a structured observation checklist based on IMPAC guidelines to observe management of labor, delivery, and the first two hours of postpartum care for both mother and newborn. As shown in Table 1, we observed a total of 60 births in the three study hospitals. No births were observed at the health centers, where they occur infrequently. Shift rotations previously scheduled by each facility determined which providers would be observed on which days and during which shifts. At least three providers from each study hospital were observed. Both observer teams were headed by an Ob/Gyn. One team also had a pediatrician and two midwives, while the other had three midwives. All were trained to apply the observation instrument in a standard fashion. Data collection began at the two regional hospitals where the teams stayed for three days, observing during the day and at night. The teams arrived on the weekend in order to include a weekend day in the observation schedule. After competency testing of the observed birth attendants at each of the regional hospitals, data collection continued at CHK, where one team covered the day shift and the other team the night shift for 48 consecutive hours.

We conducted medical record reviews to evaluate performance at managing three obstetric complications: hemorrhage, pre-eclampsia or eclampsia, and sepsis. We opted for record reviews because the time available for data collection would make unlikely the observation of a sufficient number of complications as they occurred. Three Ob/Gyns carried out all record reviews for both the Enabling Environment and Third Delay studies using the same medical histories. A description of the review process appears below under the methods section for third delay. Observers evaluated performance by determining whether the team managing each patient had carried out a set of four to ten very basic steps indicated by IMPAC guidelines as essential for each complication. As with the third delay record review, performance at managing obstetric complications was evaluated at all three hospitals.

Data on factors that contribute to an enabling environment were collected with four different instruments. The first was applied once each in the emergency room and on the obstetric ward at each facility. This instrument measured the unit's hours of operation; the presence or absence of written standards of care; and the availability of key drugs, equipment, and supplies. We refer to these as the *essential elements* of obstetric care. The list of essential elements was created based on the WHO Safe Motherhood Assessment package, IMPAC guidelines, input from Rwandan Ob/Gyns, and published literature.[5,29,30] The same group of observers who evaluated performance collected the data on essential elements. The other three instruments were completed by providers when they completed the written portion of the competency test. The instruments asked providers to list all factors that contributed in either a positive or negative way to their performance as birth attendants. This was administered in the form of a free-list according to the technique described by Weller and Romney.[31] Next, each provider responded to a written survey about the presence or absence of certain *enabling factors* in their work environment, such as adequate training, supervision, team work, and use of job aids. Finally, each provider completed a two-part, 31-item questionnaire examining different aspects of motivation. These questions had been adapted from previous research on health worker motivation in developing countries.[31-34]

C. Results

1. Health worker motivation and enabling factors

Motivation survey

The scores for both parts of the motivation survey indicate moderate levels of satisfaction, on average. The 19 items in the Satisfaction I scale focus on the health worker's job satisfaction. The 12 items in the Satisfaction II scale focus on the health worker's hospital environment. Each item is a five-point Likert scale where 1 indicates very unsatisfied and 5 very satisfied. The scales are positively and significantly correlated (Pearson r=0.378, p=0.04, n=30). Cronbach's alphas (α) for the scales indicate that they are internally consistent (Satisfaction I, α =0.778 Satisfaction II, α =0.788). Average scores for the two scales were computed by taking the mean of items in the scale, while allowing up to 25% of the items in the scale to be missing in the calculation of the index score for each individual.

Satisfaction I — Health Worker's Job (Items 1–19): Mean (SD)=0.3 (0.6), range=2.4 to 4.7, n=31.

Satisfaction II — Health Worker's Hospital Environment (Items 20–31): Mean (SD)=3.6 (0.6), range=1.9 to 4.8, n=32.

Average scores on Satisfaction I range from 3.14 (Ruhengeri Hospital) to 3.70 (Rwamagana Hospital). Average scores on Satisfaction II range from 3.47 (Rwamagana Hospital) to 3.61 (CHK).

Enabling factors

Training in past two years: A count of training in the past two years was calculated by summing training indicated on the following items: emergency obstetric care (EOC) training (item 4), interpersonal communication training (item 7), and other training on labor and delivery (item 8). Items were coded 0 for "no training" and 1 or higher for "any training," or in the case of EOC training, to indicate the number of trainings in the past two years. Mean (SD)=0.50 (1.1), range=0 to 4, n=34.

Health worker's assessment of proper use of clinical histories: A measure indicating the proper use of clinical histories was calculated by averaging three items on different aspects of clinical histories (items 11.1, 11.2, and 11.3). Each item was scored on a five-point scale ranging from 1 "never" to 5 "always," indicating the proper use and completion of clinical histories. Mean (SD)=3.7 (0.8), range=1.3 to 5, n=31.

Health worker's assessment of performance of self and others: A summary measure of the health worker's subjective assessment of different aspects of his or her performance and the performance of co-workers was calculated by averaging the following items: 13, 14, 15, 16, 17, 18, 19, and 20. Up to 25% of the items were allowed to be missing in the calculation. Items were reverse coded as needed (items 15, 17, 18 and 19). The response scale ranges from 1 "strongly disagree" to 5 "strongly agree." Mean (SD)=3.36 (0.5), range=2.25 to 4.38, n=34.

Health worker's assessment of presence of supervisory system: A count of the presence of internal and/or external supervisory systems was calculated by summing items 21 and 26 (coded 0 for "no supervisory system" and 1 for "supervisory system"). Mean (SD)=0.81 (0.7), range=0 to 2, n=31.

Motivation and enabling factors by hospital

Table 5 presents the means of the two satisfaction factors and four enabling factors for the three hospitals. Because the sample sizes are very small, these figures are not reliable.

Table 5. Motivation and enabling factors: Average scores by hospital

Hospital	Job Satisfaction (1–5)	Satisfaction with Hospital Environment (1–5)	Mean Number of Trainings in Past 2 Years	HW's Assessment of Presence of Supervisory System (0–2)	HW's Assessment of Proper Use of Clinical Histories (1–5)	HW's Assessment of Performance of Self and Others (1–5)
CHK (n=18)	3.39	3.61	0.61	1.12	3.92	3.60
Rwamagana (n=3)	3.70	3.47	1.00	0.00	3.11	3.27
Ruhengeri (n=9)	3.14	3.54	0.33	0.50	3.25	3.03

Associations between health worker motivation and enabling factors

There were many significant associations between health worker motivation and enabling factors, as listed below. All associations are positive; for example, more job satisfaction is associated with more use of clinical records.

- Job satisfaction and satisfaction with hospital ($r=0.38$, $p=0.04$, $n=30$).
- Job satisfaction and use of clinical histories ($r=0.45$, $p=0.02$, $n=29$).
- Job satisfaction and performance of self/others ($r=0.47$, $p=0.01$, $n=31$).
- Satisfaction with hospital and performance of self/others ($r=0.50$, $p<0.01$, $n=32$).
- Use of clinical histories and performance of self/others ($r=0.57$, $p<0.01$, $n=31$).
- Presence of supervisory system and performance of self/others ($r=0.43$, $p=0.02$, $n=31$).

2. Observed performance

Characteristics of birthing mothers

We observed 55 birthing mothers at the three hospitals. The mothers' characteristics are summarized in Tables 6a and 6b.

Table 6a. Characteristics of birthing mothers

	Mean	SD	Minimum	Maximum	n
Average age in years	25.4	6.2	16	41	54*
Previous births (average)	1.7	1.8	0	6	54*

Table 6b. Characteristics of birthing mothers

	n	%
First Language:		
Kinyarwanda	55	100.0
Accompanied by anyone:		
Yes	53	96.4
Missing data	2	3.6
Diagnosis of:		
Tuberculosis	2	3.6
HIV/AIDS	8	14.5
Syphillis	6	10.9
Other STI	4	7.3

*Data missing for one woman in labor

Health worker team characteristics

Composition of the health worker team was divided into three main categories: The first was physician, resident, and intern; and the second was nurse and midwife. The third included nurse/aide and other, and is referred to as “other health worker” or “non-professional” in the analysis summary below. The skill level, size, and composition of the teams summarized below are based on cases with non-missing team data. The results of these cases are given by phase and hospital in Tables 7, 8, and 9.

Labor

Number of health workers: During labor, the health worker team on average consisted of 2.1 workers (SD=1.0, range=1 to 4, n=56). Slightly more than a third of the cases (35.7%) involved care from only one worker during labor.

Team composition: Most of cases (83.9%) received care from a nurse/midwife, while a physician/resident was present during labor in 14.3% of the cases. 16.1% of the labor cases were not attended by a nurse, midwife or physician.

Intrapartum phase

Number of health workers: During the intrapartum phase, the health worker team on average consisted of 2.1 workers (SD=1.0, range=1 to 4, n=49). The number of workers providing care during the intrapartum phase was similar for one, two, and three workers: 34.7%, 28.6% and 26.5% for one, two and three health workers respectively.

Team composition: Most of cases (85.7%) received care from a nurse/midwife, while a physician/resident was present during labor in 16.3% of the cases. 14.3% of the cases were not attended by a nurse, midwife or physician.

Postpartum: Mother

Number of health workers: During postpartum care, the health worker team attending to the mother on average consisted of 1.0 workers (SD=0.3, range=0 to 2, n=49).

Team composition: Most women were attended by either one midwife/nurse (55.1%) or one non-professional health worker (36.7%). A physician was not present at any of the cases.

Postpartum: Infant

Number of health workers: During postpartum care, the health worker team attending to the neonate on average consisted of 1.0 workers (SD=0.3, range=0 to 2, n=52). Most of the cases (88.5%) received care from one health worker, but no one attended the newborn in three cases (5.8%).

Team Composition: During postpartum care of the infant, the majority of neonates received care from one nurse/midwife (55.8%) or one non-professional health worker (30.8%). Two of the newborns received care from a physician during the postpartum phase.

Team skill levels

In addition to the team characteristics above, teams were divided into two skill levels: (1) teams with skilled workers (doctor, resident, nurse, midwife, intern) and (2) teams with less skilled workers only (“other” or auxiliary health worker). See Table 7.

Table 7. Skilled versus less skilled teams

Phase	Skilled Team n (%)	Less Skilled Team n (%)	No attendance n (%)
Labor	47 (83.9)	9 (16.1)	0 (0%)
Intrapartum	42 (85.7)	7 (14.3)	0 (0%)
Postpartum: mother	30 (61.2)	18 (36.7)	1 (2.0%)
Postpartum: infant	33 (63.5)	16 (30.8)	3 (5.8%)

Table 8. Composition of team during labor, intrapartum, and postpartum, by hospital

	Patients with MD, Midwife, or Nurse on Team		
Phase	CHK % (n)	Rwamagana % (n)	Ruhengeri % (n)
Labor	95 (38)	60 (5)	62 (14)
Intrapartum	93 (30)	86 (7)	67 (12)
Postpartum: mother	76 (29)	29 (7)	46 (13)
Postpartum: newborn	75 (32)	43 (7)	46 (13)

Table 9. Size of teams in attendance during labor, intrapartum, and postpartum, by hospital

	Number of Providers Present during Phase		
Phase	CHK Average (n)	Rwamagana Average (n)	Ruhengeri Average (n)
Labor	2.1 (38)	1.4 (5)	2.3 (14)
Intrapartum	2.1 (30)	1.9 (7)	2.4 (12)
Postpartum mother	1.0 (29)	1.1 (7)	1.0 (13)
Postpartum newborn	1.0 (32)	0.9 (7)	1.0 (13)

Duration of labor and delivery observations

Beginning to end of observation: The average duration of the labor and delivery observation period was 5.5 hours (SD=3.2, range=1.3 to 15.0, n=53) (n=53, data missing from two mothers).

Beginning to time of birth: The average duration from the beginning of the labor to the time when the baby was born was 3.5 hours (SD=3.1, range=0.03 to 12.8, n=55). By hospital the average duration was 3.8 hours at CHK, 2.3 hours at Rwamagana, and 3.2 hours at Ruhengeri.

Birth to end of observation: The duration from birth to end of postpartum observation averaged 2.1 hours (SD=0.6, range=0.33 to 4.0, n=53) (n=53, data missing from two mothers).

Healthcare worker performance

Sixty observations including 55 of women in labor at the three hospitals were analyzed to show the percentage of times a task was performed. Results for the labor, intrapartum, and postpartum phases are displayed in Tables 10–17. Some of these tables use the term "missing" to refer to blank data fields or cases where the observer specifically checked that data was missing when it should not have been. "Not observed" refers to cases when the observer had to leave the observation area, the patient left the area and the observer could not follow, or the observer left the response blank or indicated it was an inappropriate question for this case, such as an immediate delivery or referral.

Table 10. Labor monitoring with partograph (n=55)

	Partograph Alert Line				Partograph Action Line			
	Yes	No	Missing	Not Observed	Yes	No	Missing	Not Observed
Number of cases (%)	20 (36.4)	27 (49.1)	0 (0.0)	8 (14.5)	20 (36.4)	26 (47.3)	2 (3.6)	7 (12.7)

Note: Five of the 60 cases were excluded because the women were not in labor.

Table 11. Frequency of monitoring during labor

	Frequency of Task Performance (per Hour) †				
	Avg. (SD)	Range	n*	Number of Cases (%)	n*
FHR checked in first hour	1.22 (0.42)	1.00 to 2.0	51	51 (92.7)	55
FHR checked after first hour	0.52 (0.40)	0.16 to 1.9	34	34 (61.8)	55
Blood pressure checked	0.49 (0.51)	0.10 to 2.4	33	33 (60.0)	55
Pulse checked	0.50 (0.65)	0.10 to 2.4	17	17 (30.9)	55
Intervals between contractions checked	0.41 (0.39)	0.08 to 1.6	29	29 (52.7)	55
Duration of contraction checked	0.37 (0.44)	0.08 to 2.0	27	27 (49.1)	55
Vaginal exam (excluding outlier)	1.16 (0.97)	0.16 to 4.8	51	52 (94.5)	55

Notes: * The sample sizes (n's) on "Frequency of Task Performance" and "Task Performed at Least Once" differ because of missing data on the duration of the observation, a variable used to calculate frequency of task performance per hour.
† "Task Performed at Least Once" indicates the number of cases where health workers completed the task at least once during the observation.
FHR=fetal heart rate.

Table 12. Frequency of monitoring during labor by hospital

	Frequency of Task Performance by Hospital (per Hour)					
	CHK	n	Rwamagana	n	Ruhengeri	n
FHR checked in first hour	1.25	36	1.00	3	1.17	12
FHR checked after first hour	0.44	25	1.30	2	0.57	7
Blood pressure checked	0.44	29	NA		0.85	4
Pulse checked	0.45	16	NA		1.33	1
Intervals between contractions checked	0.37	22	NA		0.57	7
Duration of contraction checked	0.34	21	NA		0.48	6
Vaginal exam (excluding outlier)	1.05	36	1.30	2	1.43	13

FHR=fetal heart rate.
NA=not available.

Table 13. Performance during intrapartum phase

Indicator	Yes (%)	No (%)	Not Observed (%)	Missing (%)
Hands washed**	0 (0.0)	42 (91.3)	2 (4.3)	2 (4.3)
Perineum cleaned**	21 (45.7)	20 (43.5)	2 (4.3)	3 (6.5)
New or re-sterilized gloves**	44 (95.7)	0 (0.0)	1 (2.2)	1 (2.2)
Sterile drapes and clothing**	36 (78.3)	9 (19.6)	1 (2.2)	0 (0.0)
Protect perineum**	36 (78.3)	7 (15.2)	3 (6.5)	0 (0.0)
Suction newborn*	8 (17.8)	36 (80.0)	1 (2.2)	0 (0.0)
One hand each side baby head**	36 (78.3)	6 (13.0)	3 (6.5)	1 (2.2)
Clamp and cut umbilical cord*	44 (97.8)	0 (0.0)	0 (0.0)	1 (2.2)
Use sterile instrument to cut cord*	45 (100)	0 (0.0)	0 (0.0)	0 (0.0)
Baby in skin-to-skin contact with mother*	4 (8.9)	39 (86.7)	1 (2.2)	1 (2.2)
Dry and cover newborn*	44 (97.8)	1 (2.2)	0 (0.0)	0 (0.0)
Give mother oxytocin**	31 (67.4)	11 (23.9)	2 (4.3)	2 (4.3)
Observe and manage delivery of placenta**	37 (80.4)	3 (6.5)	1 (2.2)	5 (10.9)
Confirm uterus is well-contracted**	26 (56.5)	17 (37.0)	3 (6.5)	0 (0.0)
Examine vulval-perineal region**	40 (87.0)	5 (10.9)	1 (2.2)	0 (0.0)
Examine birth canal**	9 (19.6)	33 (71.7)	4 (8.7)	0 (0.0)
Examine placenta**	25 (54.3)	21 (45.7)	0 (0.0)	0 (0.0)
Record number of blood vessels in cord*	2 (4.4)	42 (93.3)	0 (0.0)	1 (2.2)

Notes: Fourteen cases were excluded from all analyses: five women were not in labor, nine had C-sections, and one case was excluded from some of the analysis (1 stillbirth). Each case had an average of 10.7 tasks completed of the 18 listed (SD=2.1, range 7 to 15, n=45).
* n=45; ** n=46.

Table 14. Postpartum care: Mother

Indicator	Yes (%)	No (%)	Not Observed (%)	Missing (%)
Check uterine retraction**	19 (41.3)	25 (54.3)	1 (2.2)	1 (2.2)
Check external genitalia for hemorrhage**	15 (32.6)	29 (63.0)	1 (2.2)	1 (2.2)
Initiate breastfeeding within 2 hours of birth*	2 (4.4)	34 (75.6)	7 (15.6)	2 (4.4)
Check mother’s temperature**	0 (0.0)	41 (89.1)	4 (8.7)	1 (2.2)

Fourteen cases were excluded from all analyses: five women were not in labor, nine had C-sections, and one case was excluded from the item on breastfeeding (one stillbirth). Each case had an average of 0.8 tasks completed out of the four listed (SD=1.0, range 0 to 3, n=44).
* n=45; ** n=46.

Table 15. Postpartum care of the newborn

Indicator	Yes (%)	No (%)	Not Observed (%)	Missing (%)
Apply antimicrobial drops/ointment	23 (42.6)	28 (51.9)	2 (3.7)	1 (1.9)
Allow baby to breastfeed on demand	2 (3.7)	41 (75.9)	10 (18.5)	1 (1.9)
Keep infant under constant supervision	24 (44.4)	23 (42.6)	6 (11.1)	1 (1.9)
Clean blood and meconium from skin	38 (70.4)	14 (25.9)	1 (1.9)	1 (1.9)

Six cases were excluded from the analysis: five women were not in labor, and one case was a stillbirth. Each case had an average of 1.7 tasks completed out of the four listed (SD=1.2, range 0 to 4, n=52). All four tasks had n=54.

Table 16. Frequency summary: Postpartum

	Frequency of Task Performance (per Hour) †			Task Performed at Least Once		
	Mean (SD)	Range	n*	Number of Cases	%	n
Mother's pulse	0.74 (0.30)	0.34 to 1.20	12	13	24.5	53
Baby's color and respiration	1.45 (0.57)	0.35 to 3.53	36	38	70.4	54
Baby's temperature	NA	NA	NA	0	0.0	53
Umbilical cord checked	0.76 (0.41)	0.42 to 1.50	8	9	17.0	53

† Both “Frequency of Task Performance” and “Task Performed at Least Once” refer to cases. For example, in 13 out of 53 cases the mother had her pulse checked at least once in the postpartum period.
*The sample sizes (n) are number of valid cases across all hospitals. The sample sizes are less for “Frequency of Task Performance” than for “Task Performed at Least Once” because of missing data on the duration of the observation period (a variable used to calculate frequency of task performance per hour). Six cases were excluded from this analysis: five women were not in labor, and one case was a stillbirth.

Table 17. Frequency of postpartum monitoring by hospital

	Frequency of Task Performance per Case (per Hour)					
Indicator	CHK	n	Rwamagana	n	Ruhengeri	n
Mother’s pulse checked	0.70	9	NA		0.87	3
Baby’s color and respiration checked	1.47	22	1.50	1	1.41	13
Baby’s temperature checked	NA		NA		NA	
Umbilical cord checked	0.66	7	1.50	1	NA	

Notes: Five cases were excluded from this analysis because they were not in labor.
NA = not available.

3. Association between team characteristics and task performance

Only one significant association was found between number of providers on the team and task performance. All significant associations are positive; that is, more providers are associated with higher performance.

- Number of providers during labor is associated with frequency of checking the fetal heart rate in the first hour of observation (r=0.42, p=0.0004, n=44).
- Number of providers during the intrapartum phase is not associated with task performance during that phase.

- Number of providers during postpartum care for mothers is not associated with task performance during that phase.
- Number of providers during postpartum care for neonates is not associated with task performance during that phase.

4. Retrospective chart review of obstetric complications

Basic information and missing data

We reviewed 52 charts in the three hospitals, of women who experienced postpartum hemorrhage, pre-eclampsia/eclampsia, or sepsis. Tables 18–20 report the number of charts reviewed, type of delivery, and pregnancy outcome.

Many of the questions required the reviewer—in indicating whether or not some task was recorded as having been done ("yes" or "no") or if data were inadequate or missing from the charts—to check one of the pre-coded reasons: "not in chart," "illegible," "inconsistent," or "inappropriate question" for that case. Sometimes reviewers recorded no response. Missing and inadequate data were divided into two categories: "Missing" refers to cases where the observer specifically checked that data were missing, illegible, or inconsistent on the review form, and "not observed" refers to cases where the observer left the response blank or indicated it was an inappropriate question for the case, such as might occur in an immediate delivery or referral.

"Valid n" for a data item indicates the number of all charts reviewed minus the number of charts categorized as "not observed" for that data item. Throughout this section, we estimate percentage of yes responses by dividing the number of yes responses by Valid n. A minimal estimate of percentage of yes responses ("min estimate") can be calculated using the total number of charts as the denominator, and an upper-bound estimate ("max estimate") by using the sum of the yes and no responses as the denominator.

Table 18. Number of charts reviewed by hospital

	n	%
CHK	18	34.6
Rwamagana	21	40.4
Ruhengeri	13	25.0
Total	**52**	**100.0**

Table 19. Type of delivery: Chart review

	n	%
Spontaneous	30	57.7
Cesarean	13	25.0
Other	1	1.9
Missing and not observed	8	15.4

Table 20. Pregnancy outcomes: Chart review

	n	%
Live birth	36	69.2
Fetal death	4	7.7
Spontaneous abortion	4	7.7
Missing and not observed	8	15.4

Postpartum hemorrhage

Twenty-seven cases of postpartum hemorrhage were reviewed: six from CHK, 14 from Rwamagana, and seven from Ruhengeri. The quality of care received on eight yes-no indicators was scored for each case, as shown in Table 21. The pooled score over all eight indicators for all charts was 60.1% (125 yes answers out of 208) and ranged from a low of 35% (catheterized bladder) to a high of 92% (vaginal bleeding assessed; oxytocin given). The pooled min estimate was 57.9%, and the pooled max estimate was 84.5%. The results are less reliable when broken out by hospital, due to small samples per hospital (Table 22).

Table 21. Quality of care for postpartum hemorrhage: Chart review

	Number of Charts (n=27)					
Indicator	**Yes**	**No**	**Missing**	**Not Observed**	**Valid n**	**% Yes**
Signs of shock assessed	11	10	6	0	27	40.7
Vaginal bleeding assessed	24	0	2	1	26	92.3
Examined cervix for tears	15	0	11	1	26	57.7
Massaged uterus	9	0	16	2	25	36.0
Oxytocin given	24	1	1	1	26	92.3
IV infusion started	20	4	3	0	27	74.1
Catheterized bladder	9	8	9	1	26	34.6
Checked placenta	13	0	12	2	25	52.0
Total	**125**	**23**	**60**	**8**	**208**	**60.1**

Table 22. Quality of care for postpartum hemorrhage by hospital: Chart review

	CHK (n=6)			Rwamagana (n=14)			Ruhengeri (n=7)		
Indicator	**Yes**	**Valid n**	**% Yes**	**Yes**	**Valid n**	**% Yes**	**Yes**	**Valid n**	**% Yes**
Signs of shock assessed	5	6	83.3	3	14	21.4	3	7	42.9
Vaginal bleeding assessed	6	6	100	11	13	84.6	7	7	100
Examined cervix for tears	6	6	100	8	13	61.5	1	7	14.3
Massaged uterus	6	6	100	3	12	25.0	0	7	0.0
Oxytocin given	6	6	100	12	13	92.3	6	7	85.7
IV infusion started	5	6	83.3	11	14	78.6	4	7	57.1
Catheterized bladder	5	6	83.3	3	13	23.1	1	7	14.3
Checked placenta	5	5	100	7	13	53.8	1	7	14.3
Total	**44**	**47**	**93.6**	**58**	**105**	**55.2**	**23**	**56**	**41.1**

Pre-eclampsia and eclampsia

Thirteen cases of pre-eclampsia/eclampsia were reviewed, six from CHK, six from Rwamagana, and one from Ruhengeri. The quality of care received on nine yes-no indicators was scored for each case, as shown in Table 23. The pooled score over all nine indicators for all charts was 67.0% (65 yes answers out of 97) and ranged from a low of 38.5% (parenteral hydralazine given) to a high of 100% (blood pressure assessed). The pooled min estimate was 27.8%, and the pooled max estimate was 80.2%. The results are less reliable when broken out by hospital due to small samples per hospital (Table 24).

Table 23. Quality of care for pre-eclampsia and eclampsia: Chart review

Indicator	Number of Charts (n=13) Yes	No	Missing	Not Observed	Valid n	% Yes
Blood pressure assessed	13	0	0	0	13	100
Fetal condition assessed	8	0	1	4	9	88.9
Checked for proteinuria	7	4	2	0	13	53.8
Parenteral $MgSO_4$ given	8	3	2	0	13	53.8
Parenteral hydralazine given	5	6	2	0	13	38.5
Monitored respirations	10	2	1	0	13	76.9
Placed on left side	6	1	6	0	13	46.2
Delivered within 12 hours of onset of convulsions	4	0	1	8	5	80.0
Delivered within 24 hours if severe pre-eclampsia	4	0	1	8	5	80.0
Total	**65**	**16**	**16**	**20**	**97**	**67.0**

Table 24. Quality of care for pre-eclampsia and eclampsia by hospital: Chart review

	CHK (n=6)			Rwamagana (n=6)			Ruhengeri (n=1)		
Indicator	Yes	Valid n	% Yes	Yes	Valid n	% Yes	Yes	Valid n	% Yes
Blood pressure assessed	6	6	100.0	6	6	100.0	1	1	100.0
Fetal condition assessed	2	2	100.0	6	6	100.0	0	1	0.0
Checked for proteinuria	4	6	66.7	3	6	50.0	0	1	0.0
Parenteral $MgSO_4$ given	4	6	66.7	4	6	66.7	0	1	0.0
Parenteral hydralazine given	1	6	16.7	3	6	50.0	1	1	100.0
Monitored respirations	6	6	100.0	4	6	66.7	0	1	0.0
Placed on left side	6	6	100.0	0	6	0.0	0	1	0.0
Delivered within 12 hours of onset of convulsions	1	1	100.0	3	3	100.0	0	1	0.0
Delivered within 24 hours if severe pre-eclampsia	1	1	100.0	3	3	100.0	0	1	0.0
Total	**31**	**40**	**77.5**	**32**	**48**	**66.7**	**2**	**9**	**22.2**

Sepsis

Sepsis was defined to include chorioamnionitis, puerperal sepsis, and septic abortion: 21 cases were reviewed, including nine from CHK, six from Rwamagana, and six from Ruhengeri. The quality of care received on three yes-no indicators was scored for each case, as shown in Table 25. The pooled score over all three indicators for all charts was 89.8% (53 yes answers out of 59) and ranged from a low of 77.8% (foul-smelling vaginal discharge assessed) to a high of 100% (combination of antibiotics given). The pooled min estimate was 84.1%, and the pooled max estimate was 94.6%. The results are less reliable when broken out by hospital, due to small samples per hospital (Table 26).

Table 25. Quality of care for sepsis: Chart review

Indicator	Number of Charts (n=21)					
	Yes	No	Missing	Not Observed	Valid n	% Yes
Fever assessed	18	1	1	1	20	90.0
Foul-smelling vaginal discharge assessed	14	2	2	3	18	77.8
Combination of antibiotics given	21	0	0	0	21	100.0
Total	**53**	**3**	**3**	**4**	**59**	**89.8**

Table 26. Quality of care for sepsis by hospital: Chart review

	CHK (n=9)			Rwamagana (n=6)			Ruhengeri (n=6)		
Indicator	Yes	Valid n	% Yes	Yes	Valid n	% Yes	Yes	Valid n	% Yes
Fever assessed	9	9	100	5	6	83.3	4	5	100
Foul-smelling vaginal discharge assessed	9	9	100	5	6	83.3	0	3	0.0
Combination of antibiotics given	9	9	100	6	6	100	6	6	0.0
Total	**27**	**27**	**100**	**16**	**18**	**88.9**	**10**	**14**	**71.4**

5. Missing and not observed data items

Many data items were missing or not observed, as summarized in Table 27. (See also Tables 21, 23, and 25.) Overall, 20% of data items were missing, and 8% were not observed. Across complications, the largest percentage of missing data items was in postpartum hemorrhage, with nearly 28% missing compared to under 5% in sepsis. Across hospitals, Ruhengeri had the highest percentage of missing items (nearly 40%) while CHK had less than 3%. This high rate of missing data raises concerns about the reliability of the results.

Table 27. Missing and not observed data items by hospital and complication: Chart review

Hospital (n for PPH/Eclampsia/Sepsis)	PPH Data Items (% of n)		Eclampsia Data Items (% of n)		Sepsis Data Items (% of n)		Total Data Items (% of n)	
	Missing	Not Observed	Missing	Not Observed	Missing	Not Observed	Missing	Not Observed
CHK (n=48/54/27=129)	1(2.1)	1(2.1)	2(37.0)	14(25.9)	0(0.0)	0(0.0)	3(2.3)	15(11.6)
Rwamagana (n=112/54/18=184)	32(28.6)	7(6.3)	10(18.5)	6(11.1)	1(5.6)	0(0.0)	43(23.4)	13(7.1)
Ruhengeri (n=56/9/18=83)	27(48.2)	0(0.0)	4(44.4)	0(0.0)	2(11.1)	4(22.2)	33(39.8)	4(4.8)
Total (n=216/117/63=396)	60(27.8)	8(3.7)	16(13.7)	20(17.1)	3(4.8)	4(6.3)	79(19.9)	32(8.1)

Note: The sample size (n) for data items for a particular complication and hospital equals the number of charts reviewed in the hospital with that complication times the number of indicators for that complication.

D. Discussion

1. Data collection

Of the three studies, the Enabling Environment Study has the most data collection forms and perhaps the most complications. The essential elements data collection form (R.2.5) is relatively easy to use but difficult to analyze because of the many types of medications and dosages. The form used to record the direct observation of care during normal labor and delivery (R.2.4) sometimes required the observer to stay focused over a long period in order to monitor the care provided during a labor that extended over many hours. To save time, observers may have tried to monitor two or three labor cases at once using this instrument, which could lead to questionable data when one (or more) of the cases goes to the delivery phase. This was overcome by placing one observer in the labor room and another in the delivery room. The form used to do a chart review of obstetric complications (R.4.2) requires a reviewer with a strong clinical background and qualifications to interpret the data, often ambiguous, in the charts. The motivation (R.2.2) and enabling factors (R.2.3) questionnaires seem to have worked well.

2. Findings

Overall, most of cases were attended by staff of advanced professional training (physicians or nurses). However, this varied by hospital, where CHK had far more nurses and physicians attending all phases than Rwamagana or Ruhengeri hospitals, and by phase, where labor had more physicians and nurses in attendance than the other phases. In spite of the advanced training, fewer than half of the attending health workers said they had received any training in the last two years.

Labor monitoring appears to be very inadequately performed. WHO guidelines indicate that the fetal heart rate (FHR) should be measured every 5 minutes (12 times per hour) during the first hour and every 15 minutes (4 times per hour) thereafter. Data from the direct observations indicate that this was done on average only 1.2 times per hour in the first hour of labor and only 0.5 times per hour thereafter. Thus, many cases were not measured sufficiently often to detect fetal distress. A similar failing was apparent for monitoring of the mother. For example, the guidelines state that blood pressure and duration of contractions should be measured twice per hour, but on average, blood pressure was measured 0.5 times per hour and contractions 0.4 times per hour. Instead, vaginal exams were frequent: 1.2 times per hour. Inadequate labor monitoring means that many complications might not be noticed in time for appropriate corrective action. (Some mothers arrive at the facility at the end of labor, already in the intrapartum phase or even after delivery, precluding labor monitoring. If not accounted for correctly, this could cause a falsely low estimated average frequency of monitoring during labor. This was accounted for in the analysis.)

Use of the partograph during labor was also low. The alert line was completed in only 42.6% of the cases (20/47, eight not observed) and the action line in only 41.7% of the cases (20/48, seven not observed).[1]

The following practices were observed during the intrapartum (delivery) phase:

- In none of the cases (0/44, two not observed) did the staff wash their hands before attending the patient;
- In 47.7% of the cases (21/44, two not observed), the staff cleaned the perineum;
- In 70.5% of the cases (31/44, two not observed), the staff gave the mother oxytocin;
- In 21.4% of the cases (9/42, four not observed), the staff examined the birth canal.

These figures show that performance varies, with very few washing their hands or examining the birth canal, but most giving oxytocin to the mother after delivery.

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[1] The percentage performed correctly assigns "yes" responses to the numerator and the sum of "yes," "no," and "missing" to the denominator. "Not observed" instances are not included in the calculation. This same definition is used for all percentage calculations in this section.

During the first two hours postpartum, both the uterine retraction was checked at least once in only 42.2% of the cases (19/45, one not observed) and the external genitalia were checked at least once in only 33.3% of the cases (15/45, one not observed). The mother's temperature was never checked in 42 cases (0/42, four not observed). Monitoring of newborns during the postpartum phase was somewhat better. Antimicrobial ointment was applied in 44.2% of the cases (23/52, two not observed), while the baby was cleaned of blood and meconium in 71.7% of the cases (38/53, one not observed). Newborns were under constant surveillance in half the cases (24/48, six not observed).

The data obtained from the charts of patients with maternal complications indicated that many tasks were performed to standard. Of the three complications reviewed, management of sepsis was performed better (89.8%, 53/59, four not observed) than that of pre-eclampsia (67.0%, 65/97, 20 not observed) and postpartum hemorrhage (60.1%, 125/208, eight not observed). For sepsis cases, the charts indicated that key tasks were generally performed; for example, fever was assessed 90% of the time (18/20) and a combination of antibiotics was given 100% of the time (21/21). For pre-eclampsia cases, the chart review indicated mixed performance; for example, parental hydralazine was given 38.5% of the time (5/13), and the mother was placed on the left side 46.2% of the time (6/13), while blood pressure was assessed 100% of the time (13/13), and fetal condition was assessed 88.9% of the time (8/9). Similarly, the chart review recorded mixed performance for postpartum hemorrhage cases; for example, signs of shock were assessed 40.7% of the time (11/27), the uterus was massaged 36.0% of the time (9/25), and the bladder was catheterized 34.6% of the time (9/26), while vaginal bleeding was assessed and oxytocin was given 92.3% of the time (24/26) and intravenous solution was started 74.1% of the time (20/27).

However, 28.0% of the data from the charts was either "missing" or "not observed." This included 31.5% from hemorrhage cases, 30.8% from pre-eclampsia cases, and only 11.1% from sepsis cases. Postpartum hemorrhage with a sample size of 216 was the largest source of missing data, although missing data are also important for pre-eclampsia (n=113). If these data were present, their inclusion could significantly influence the figures reported here for hemorrhage and pre-eclampsia case management. The more conservative approach is to assume that cases with less information are cases where management was inadequate. This has been done in part in the currently reported figures, which include "missing" data in the denominator but not "not observed" data. Including the "not observed"' data in the denominator would lower the reported performance from the current level.

IV. Third Delay Study

A. Objectives

Objectives for the Third Delay Study included: (1) define and measure the third delay for the treatment of obstetrical emergencies within facilities, (2) develop methods to measure the time interval for components of intra-facility emergency obstetric care and document apparent factors related to delayed care, and (3) develop measures useful for monitoring changes that occur after quality improvement interventions.

B. Methods

All three study hospitals also participated in the Third Delay Study: the Kigali reference hospital (CHK) and the regional-level hospitals in Ruhengeri and Rwamagana. To measure components of the third delay, we used patient flow analysis in the obstetrics ward and a medical record audit. The patient flow analysis methodology has been used in other studies to document waiting times during family planning outpatient visits,[35] and we adapted it for in-patient observations. As shown in Table 1, the local study team completed 64 observations on obstetrics wards and 85 medical record reviews.

Patient flow analysis: A Rwandan maternity ward serves as an admitting and triage area for all obstetrics patients whether or not they arrive at the hospital with an emergency condition. Our patient flow methodology helped us collect information on the following key events:

1. The time of the woman's arrival at the hospital;
2. The time the woman entered the maternity ward;
3. The time the initial exam began;
4. The time of the first exam by a senior health professional (i.e., a doctor or other provider with sufficient training to diagnose and treat rather than just record signs or symptoms);
5. The time a senior health professional gave verbal or written orders for treatment or tests;
6. The time a complication was diagnosed;
7. The time medications were given, specifically, any antibiotics, oxytocin, or magnesium sulfate ($MgSO_4$);
8. The time procedures were conducted, specifically, forceps/vacuum extraction or C-section deliveries, dilation and curettage, or laparotomy;
9. Date and time of the birth, if the woman was in labor;
10. Final diagnosis;
11. Number of times vital signs and uterine contractions were monitored; and
12. The time a patient was discharged or transferred and condition at discharge (hospitalized, referred, discharged to home, discharged against medical advice, or deceased).

The team of observers was stationed on the maternity ward to record the information for the patient flow analysis. Observations were made during two or three consecutive days including one weekend day. "Time of arrival" was defined as entry into the hospital compound. The observers could see the entry gate from the maternity ward at two hospitals. At the third, vehicles could drive to the maternity ward entrance; if the woman was on foot, an observer would ask if she had been delayed between the gate and the maternity ward entrance.

<u>Medical record review</u>: The three obstetricians were selected to carry out the medical record review because of their clinical expertise, their experience working at the reference hospital, and their familiarity with clinical records. In each hospital records were selected from calendar year 2001 by reviewing the delivery log books, listing all patients with the five obstetric emergencies listed below, and selecting a systematic sample of five from each emergency type:

1. Postpartum hemorrhage;
2. Severe pre-eclampsia or eclampsia;
3. Obstructed labor (cephalopelvic disproportion);
4. Chorioamnionitis or puerperal sepsis; and
5. Septic abortion or post-abortion vaginal, uterine, or intestinal lesions.

This process led to a selection of 25 cases per hospital. Once selected, each medical record was reviewed using a form designed to capture information about the initial exam performed in the emergency room and on the obstetrics ward, diagnosis, and definitive treatment. Questions were included for postpartum hemorrhage, pre-eclampsia or eclampsia, sepsis, endometritis, and chorioamnionitis. As noted above, this more detailed information was used to evaluate performance at managing obstetric complications for the Enabling Environment Study.

C. Results

1. Patient flow analysis

<u>Arrival to initial evaluation</u>: Sixty-six patients were observed for the patient flow analysis. Of these, 58 were in labor, six were not, and two were incoming transfers. Time intervals were measured from arrival at the facility gate or from entry into the obstetrics ward to initial evaluation. For each interval, incoming transfers were evaluated the fastest, followed by women in labor and then women not in labor (see Figures 2 and 3). The mean time interval for all patients arriving at all hospitals from arrival to initial evaluation was 12.6 minutes: The longest was at Rwamagana (22.0 minutes) and the shortest at Ruhengeri Regional Hospital (3.1 minutes) (see Figure 4).

Time to C-section: We were able to measure the time interval between decision for a C-section and start of C-section for nine patients, all but one at CHK. Of the nine, two were diagnosed as failure to progress, three had fetal distress, two were malpresentations, and two were repeat C-sections. In the first hour after the decision to operate, surgery had begun on only one of the nine patients. In the second hour after the decision, four C-sections had begun, and in the third hour two more were started. The remaining two took (1) three hours and (2) five hours and 10 minutes to begin after the decision to operate. The mean time from decision to operate and start of C-section was 2 hours and 8 minutes (range: 40 minutes to 5 hours and 10 minutes).

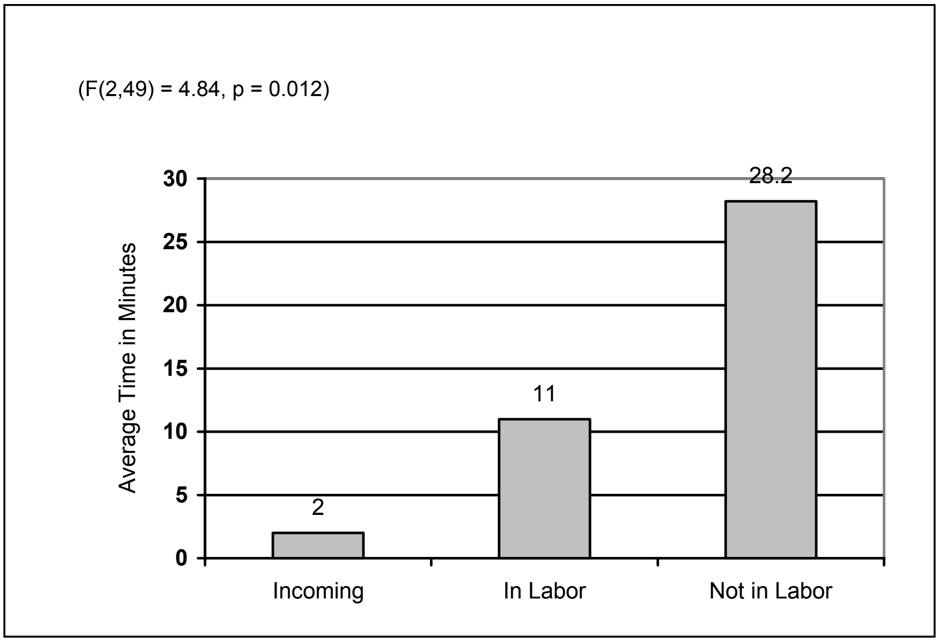


Figure 2. Time interval from arrival to initial evaluation

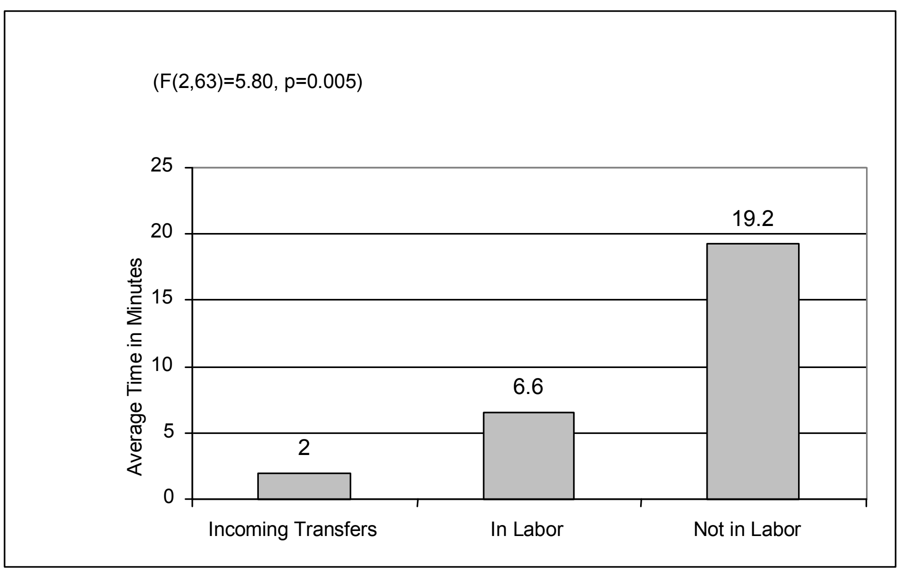


Figure 3. Time from entry into obstetrics ward to initial evaluation

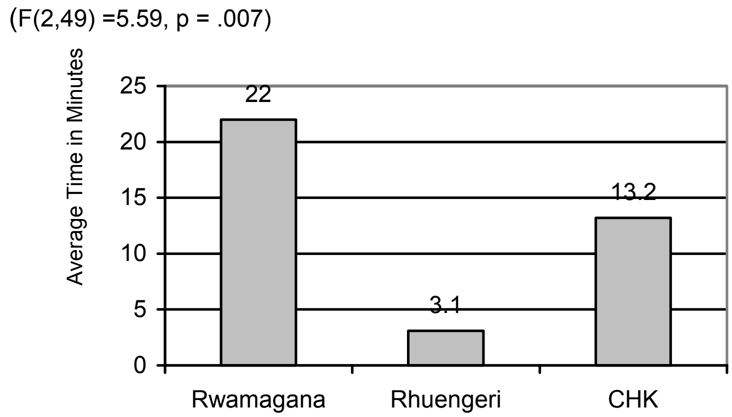


Figure 4. Time interval from arrival to initial evaluation, by hospital

Time from diagnosis to definitive treatment***:*** For eight patients diagnosed with obstructive labor, we were able to measure the interval between the diagnosis of obstructive labor and the definitive treatment, either C-section or forceps/vacuum extraction. The mean time for all eight was 3 hours (range: 15 minutes to 8 hours and 7 minutes). Two were delivered in the first hour after diagnosis, two in the second hour, two in the third hour, and two in the fourth. One patient with postpartum hemorrhage after a home delivery had a manual removal of the placenta completed 15 minutes after arrival at the hospital.

Third delays: Of the 66 patients observed during patient flow analysis, 14 (21.2%) had a delay in their care. Reasons for the delays were:

- Patient waited 40 minutes after arrival for initial exam;
- Patients had to wait for initial exam as there is only one exam table,
- Doctor took 50 minutes to arrive after notification;
- Unable to alert doctor as vehicle was not available; doctor arrived two hours and seven minutes later;
- Delay in notifying doctor;
- Ampicillin prescription filled after two hours;
- Materials not prepared to clamp cord, resulting in newborn asphyxia;
- Emergency incoming transfer failed vacuum extraction and was sent for C-section;
- Took 46 minutes to transfer newborn with respiratory distress to intensive care;
- Delay in monitoring patient as nurses were busy;
- Pharmacy was closed and key was at home with supervisor;
- Spent 43 minutes looking for money to pay patient's bill before starting IV and oxytocin;
- While staff searched for gloves to perform initial vaginal exam, newborn delivered; and
- Patient sent to operating room for C-section, returned to obstetrics ward for sonogram to determine dates, then back to operating room.

Time from arrival to delivery: Twenty-three percent of patients in labor delivered within the first hour of arrival. Deliveries in the first hour are displayed by hospital in Figure 5. Patients who delivered in the first hour delivered, on average, 22.3 minutes after arrival at Rwamagana and 37.7 minutes after arrival at Ruhengeri. These deliveries may represent the first or second delay of the three-delay model.

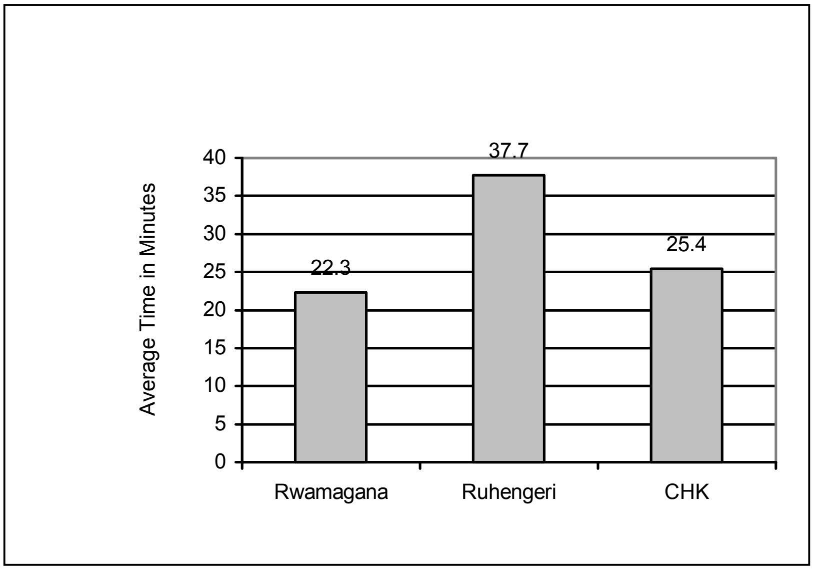


Figure 5. Mean time in minutes of patients delivered by hospital

2. Medical record reviews

Eighty-five medical records were reviewed: 30 at CHK, 30 at Rwamagana, and 25 at Ruhengeri. Of these 85, 25 patients delivered by C-section, and 22 were emergency incoming transfers, and there were 11 fetal deaths and 50 live births. The 85 cases generated 95 diagnoses that fit the study criteria, as 10 patients had dual diagnoses (Table 28).

Table 28. Number of records reviewed by type of obstetric emergency

Type of Obstetric Emergency	Number of Records Reviewed
Postpartum hemorrhage	24
Eclampsia/severe pre-eclampsia	13
Obstructed labor	23
Sepsis	
Chorioamnionitis	1
Puerperal sepsis	14
Post-abortion complications	
Septic abortion	13
Uterine lesions	7
Dual diagnoses	10

The record reviewer, a practicing Ob/Gyn, determined if a delay occurred at any of three different points in the care of the patient: initial evaluation, diagnosis, and definitive treatment. For the initial evaluation the reviewer determined if there had been a delay in evaluating the patient based on the information available in the chart. Delays in the initial evaluation were recorded if a patient had not been evaluated on arrival or if she had not been monitored adequately, resulting in a delayed recognition of an obstetric emergency. The reviewer next used his or her expert judgment and the information in the record to determine if a delay had occurred in diagnosing an obstetric emergency. Finally, the reviewer determined if there had been a delay in the treatment for each emergency. The definitive treatment for each emergency was considered when determining the delay. Table 29 displays the results by diagnosis category. Of the 85 records reviewed, 17 (20%) had at least one type of delay, according to the reviewers. Seven of 56 cases (12.5%) had delays in the initial evaluation, seven of 55 (12.7%) had delays in the diagnosis, and 14 of 61 (23%) had delays in the definitive treatment. The greatest number of delays was in receiving the definitive treatment in patients diagnosed with obstructed labor (see Table 29).

Table 29. Number of cases with delays in initial evaluation, diagnosis, and definitive treatment for five major obstetric emergencies

Type of OB Emergency	Delay in Initial Evaluation (n=7)	Delay in Diagnosis (n=7)	Delay in Definitive Treatment (n=14*)
Postpartum hemorrhage	0	1	1
Eclampsia/severe pre-eclampsia	2	3	4
Obstructed labor	3	3	10
Sepsis	0	0	0
Chorioamnionitis			
Puerperal Sepsis			
Post-abortion complications	2	0	0
Septic abortion			
Uterine lesions			

* One case with dual diagnosis of eclampsia and obstructed labor.

Examples of reasons for delays are listed in Table 30.

Table 30. Examples of reasons for delay

Type of Delay	Examples
Delay in initial evaluation	Arrived at night or on weekend Waited 1 hour and 30 minutes for initial exam
Delay in diagnosis	Arrived at night or on weekend No diagnosis Incorrect diagnosis No ultrasound machine Diagnosis 8 hours late--unable to make diagnosis Uterine rupture not diagnosed on arrival: misinterpretation of presenting symptoms
Delay in definitive treatment	Arrived at night or on weekend Personnel not available for C-section Patient unable to pay

3. Time intervals from diagnosis to definitive treatment

We could calculate time intervals from diagnosis to definitive treatment from only 19 of 85 records (see Tables 31 and 32). As there were outliers within each set of time intervals, we calculated the overall mean and the interquartile range (25th to 75th percentile) to show how the middle 50% of the distribution is scattered. Due to the small sample sizes we were unable to determine if the average time was significantly different between the two hospitals.

Figures 6 and 7 display two of these intervals as two boxplots showing the median value as the bold line and the interquartile range as the shaded area.

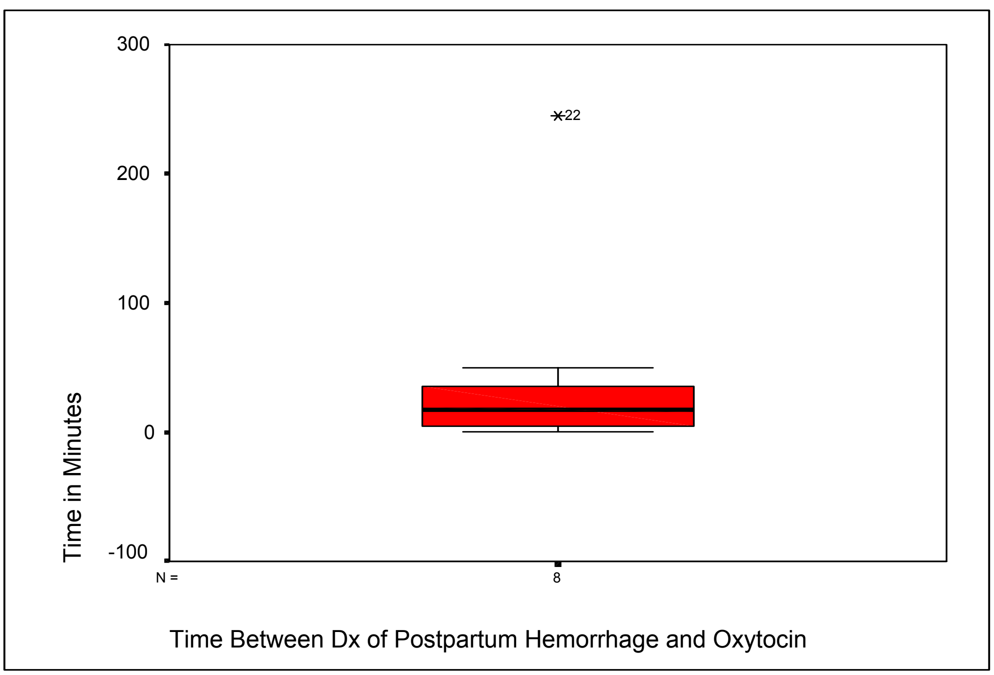
Table 31. Mean time interval from diagnosis to administration of definitive treatment by hospital (in minutes)

Diagnosis	CHK	Rwamagana	Ruhengeri	Overall Mean (25th to 75th %)
Postpartum hemorrhage (n=8) Oxytocin	60 n=6	0 n=2	-	45 (3–43)
Pre-eclampsia/eclampsia Anticonvulsants	24 n=4	1380 n=1	-	295 (18–705)
Obstructed labor (n=11) Delivery	179 n=6	209 n=5	-	193 (20–285)
Post-abortion complications Curettage	224 n=5	-	-	224 (35–485)

Table 32. Mean time interval from order to administration of definitive treatment by hospital (in minutes)

Treatment	CHK	Rwamagana	Ruhengeri	Overall Mean (25th to 75th %)
Antibiotic	44 n=9	-	-	44 (30–60)
Oxytocin	54 n=6	-	-	54 (10–90)
Anticonvulsant	18 n=4	-	-	18 (6–29)

Figure 6. Time between diagnosis of postpartum hemorrhage and oxytocin



The solid bar is the “Median”. The colored bar/box is the “Interquartile Range (25–75%)”, The I-bar is the “Range”. Asterisks refer to extreme cases.

Figure 7. Interval between diagnosis of obstructed labor and delivery

The solid bar is the "Median". The colored bar/box is the "Interquartile Range (25–75%)",
The I-bar is the "Range". Asterisks refer to extreme cases.

D. Discussion

1. Data collection

A sample of cases was drawn from the birth register for the record reviews as there was no other mechanism for tracking patients with the obstetric complications that we had targeted. Eclampsia is relatively rare in Rwanda, so we could not sample many patients with that complication. The quality of the medical records in Ruhengeri and Rwamagana, especially in terms of the documentation of time, was not as good as at CHK. Also, maternity records were often filed with all other hospital patient records, making them difficult to locate.

2. Findings

The mean time interval from arrival to initial evaluation was quite different at the two regional hospitals. The shorter time interval (three minutes) at Ruhengeri Hospital indicated that all patients were quickly triaged with an initial exam. At Rwamagana Hospital, where the mean time was 22 minutes, an emergency patient may run the risk of not being diagnosed very quickly. In order to address this, Rwamagana staff could assess the process used for triaging all incoming patients. In the course of doing this, they may wish to determine how incoming patients are triaged at other hospitals, in order to develop a change that will result in an improvement at their hospital.

The time to C-section of 128 minutes is based on CHK alone: This interval wasn't assessed at the regional hospitals, but could be to determine whether delays occur there as well.

The medical record review indicated that delays in care occurred most often in cases of obstructed labor. Two data sources found essentially identical mean time intervals between diagnosis and definitive treatment: The medical record review found a mean interval of 193 minutes (11 records), and patient flow data found it to be 188 minutes (8 observations). Efforts should be made to reduce delays using a quality improvement approach.

There was little or no time documentation at the two regional hospitals, making it difficult to assess time intervals through a medical record review. We recommend that an initiative to improve medical record documentation be implemented at these two sites.

V. Conclusion

The obstetrician team leader for each hospital and Dr. Bucagu conducted a preliminary feedback to each of the regional hospitals immediately following the in-country data collection in March 2002. This included thanking the hospital staff for their collaboration, providing impressions on the quality of the maternity services based on the observations, and discussing hospital staff expectations of the study and next steps for improving the quality of care.

As a result of the data presented here, several activities are suggested. These focus on improving the quality of care and the competence of the healthcare providers. Based on the observations of normal deliveries, a quality improvement program could use the hospital-specific results in this report as a baseline with which to work on improving each component of care. A team of staff could use a quality improvement methodology to investigate system-related causes of poor compliance with the task at that hospital. To improve provider competence, particularly in the area of obstetric emergencies, specific knowledge and skills could be taught or practiced within each hospital. One hospital requested a copy of the knowledge test so it could be used as a group study tool for learning the content tested. The emergency obstetric skills that were tested with the mannequins could also be practiced within hospital-specific groups.

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Appendix A. List of Study Instruments

Code	Name/Description
1. Competency Study	
R.1.1	Knowledge test
R.1.2	Case studies: Use of the partograph
R.1.3	Frequency and perceived difficulties of clinical techniques
R.1.4	Checklist: Neonatal resuscitation with ambu bag
R.1.5	Checklist: Neonatal resuscitation: Mouth-to-mouth and nose
R.1.6	Checklist: Manual removal of placenta
R.1.7	Checklist: Bimanual uterine compression
R.1.8	Checklist: IV insertion
2. Enabling Environment Study	
R.2.1	Enabling factors for the labor and delivery room
R.2.2	Motivation questionnaire
R.2.3	Enabling factors questionnaire
R.2.4	Observation of care during normal labor and delivery
R.2.5	Questionnaire on essential elements for the delivery room in-charge
3. Third Delay Study	
R.3.2	Patient flow: Emergency service
R.3.3	Patient flow: Maternity
4. All-Study Instruments	
R.4.1	Registration form for the initial visit
R.4.2	Chart review of obstetric complications
R.4.3	Registration form for healthcare providers

Appendix B. Schedule of In-Country Data Collection (2002)

Sunday, March 3: Arrive Kigali (Djibrina, Boucar)

Week of March 4th: Site visits, approvals, hiring observers, vehicle(s) (Djibrina, Boucar)

Sunday, March 10: Arrive Kigali (Edson)

Monday, March 11: Briefing at USAID (Boucar, Djibrina, Edson, Leonard Bagilishya)

Tuesday, March 12: Site visits to Rwamagana and CHK (Djibrina, Edson, Bucagu)

Wednesday, March 13: Site visit to Ruhengeri (Djibrina, Edson, Bucagu)

Thursday, March 14: Revision of data collection instruments, make copies, plan training and data collection (Djibrina, Edson, Bucagu)

Friday, March 15: Training of data collectors: observations, patient flow (Djibrina, Edson, Bucagu)

Saturday, March 16: Team A to Ruhengeri, begin data collection; Team B to Rwamagana, begin data collection

Sunday, March 17: Team A in Ruhengeri, continue data collection; Team B in Rwamagana, continue data collection

Monday, March 18: Team A in Ruhengeri, continue data collection; Team B in Rwamagana, continue data collection

Tuesday, March 19: Team A: Competency test, written and skills test, Ruhengeri; Team B: Written competency test, Rwamagana

Wednesday, March 20: Team A: Planning meeting in afternoon for CHK; Team B: Competency test, skills test in morning, Rwamagana, planning meeting in afternoon for CHK

Thursday, March 21: CHK data collection

Friday, March 22: Debriefing USAID (Boucar, Edson, Djibrina): CHK data collection

Saturday, March 23: Competency test, written and skills tests, CHK: Training for medical record review (Edson, Djibrina, Bucagu)

Sunday, March 24: Departure of Edson

March 25–29: Review of medical records (Djibrina, Bucagu, Vincent Kanimba, Athanase Sengorere)

March 29: Departure of Djibrina

Appendix C. Additional Data for SBA Competency Study

Table 1. Mean knowledge score, technical nurse (*infermier A3*) versus other providers

	Mean Score (Percentage of Questions Answered Correctly			
Knowledge Area	**Technical Nurses (n=5)**	**Others (n=29)**	**Mean Difference**	**p-value**
Total score	27.1	49.9	- 22.8	* 0.046
Asepsia/antisepsia	8.6	38.9	- 30.3	* 0.002
Labor and delivery	37.3	53.9	- 16.6	* 0.019
Immediate newborn care	29.1	46.7	- 17.6	0.352
Postpartum hemorrhage	23.1	47.0	- 23.9	* <0.001
Pregnancy-induced hypertension	17.8	57.8	- 40.1	* <0.001
Sepsis	16.7	43.1	- 26.4	*0 .009
Active management of third stage of labor	10.0			

Table 2. Mean knowledge score, health center versus hospital providers*

	Percentage Point Difference in Mean Score		
Knowledge Area	**Health Center**	**Reference Hosp**	**District Hosp**
Total score	27.1	50.3	45.7
Asepsia/antisepsia	8.6	18.1	11.0
Labor and delivery	37.3	60.6	54.8
Immediate newborn care	29.1	54.9	64.0
Postpartum hemorrhage	23.1	46.2	35.3
Pregnancy-induced hypertension	17.8	58.9	48.4
Sepsis	16.7	44.9	50.0
Active management of third stage of labor	10.0	5.8	1.7

*Due to small sample size, these differences cannot be tested for statistical significance.

Table 3. Mean skills score, technical nurse (*infermier A3*) versus other providers

	Mean Score (Percentage of Questions Answered Correctly)			
Knowledge Area	**Technical nurses (n=5)**	**Others (n=14)**	**Mean difference (in percentage points)**	**p-value**
Overall skill	35.2	55.5	- 20.3	0.012*
Aseptic procedure	36.0	60.0	- 24.0	0.003*
Patient rapport	22.9	36.2	- 13.4	0.246
Resuscitation with ambu bag	29.6	48.1	- 18.6	0.025*
Resuscitation mouth-to-mouth and nose	31.1	49.6	- 18.5	0.003*
Manual removal of placenta	32.6	57.7	- 25.1	0.045
Bimanual uterine compression	22.1	46.6	- 24.5	0.017*
IV placement	64.4	77.0	- 12.5	0.055*

***Significant at p<0.05 level.**

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